THE LEPIDOPTERA OF PORTUGAL

By Albert Zerkowitz

INTRODUCTION

This paper has been written with the object of providing an analysis of the Portuguese lepidopterous fauna with special regard to the zoogeographical problems connected with the same. Besides the material collected by myself in Portugal I have used the records to be found in the literature as far as I had good reasons to consider them reliable. The policy which I have followed is a very conservative one. Doubtful records have generally been omitted, but wherever there was a special interest in including data, the accuracy of which was somewhat in doubt, I have made an observation to that effect. Species, the occurrence of which is not quite certain, have not been numbered in the systematic list. Fortunately enough, several of the local collectors have been in close contact with internationally known authorities who identified or described a great part of their material. For this reason the entirely reliable records are quite numerous.

This paper does not pretend to be complete. However, if we compare the number of species in well known groups, such as the Rhopalocera, with generally neglected families of Microlepidoptera, we find that the latter are fairly well represented. I have generally found that, in temperate regions, the number of species of Rhopalocera is about one-twelfth of the total number of species of Lepidoptera of all families occurring in the same region. This also holds true for Portugal for with 116 species of Rhopalocera against a total of 1216 species of Lepidoptera of all families, which I am listing, we are not very far from reaching this proportion. There is probably no species of Rhopalocera still unrecorded, and there may not be too many species of Heterocera (including Microlepidoptera) still to be discovered in Portugal.

Due to the war I was not in a position to examine the material of Portuguese origin, still unpublished, which may be found in European collections.

On my first collecting trip in Portugal, I was surprised to note how different the fauna was from that of any other part of the Mediterranean region which I had visited before. This impression was confirmed in the course of later, closer observation. This is the first reason for which I decided to write this paper and a second, but not less important, is as follows: Most surprisingly, Portugal is one of the very few areas in Europe about which no paper dealing with all families of Lepidoptera has yet been published. The existing literature consists mainly of local faunal lists covering the vicinity of the particular place or places where their authors have resided and ignoring the species occurring in the rest of Portugal. Wattison's excellent work (1928–1930) is by far the most complete but unfortunately it deals only with Rhopalocera. In none of these papers are the problems of modern zoogeography elaborated.

Upon consulting the available literature I found that a great many species which I found in Portugal, some of them even common, were not recorded from Portugal so far. Standard works, like those of Seitz and Spuler, give as the distribution of a number of species occurring in Portugal: "in Southern Europe except Spain and Portugal" or they simply omit the entire Iberian Peninsula from the areas which they enumerate. Other species are well known from Spain but were not previously recorded from Portugal. Portugal being the southwesternmost part of the European continent, the new record of the occurrence in Portugal of a given species extends often in a southwestern direction the known area of its distribution.

For all these reasons I thought that the publishing of this paper, incomplete as it may be, was worthwhile. It will be the task of lepidopterists, who may have, in the future, the opportunity to study the fauna of Portugal, to complete our knowledge of the Lepidoptera of this interesting region.

I wish to thank all those from whom I have received suggestions or criticisms in connection with my paper. My greatest debt is to Mr. Herbert F. Schwarz and Mr. William P. Comstock, through whose understanding of my studies the facilities of the American Museum of Natural History were made available to me. Without these facilities this work could not have

been accomplished. Mr. Comstock has also kindly reviewed my manuscript. Mr. E. P. Wiltshire, F.R.E.S., made many valuable suggestions based on his knowledge of the Mediterranean area. Last but not least Senhor Fernando Mendes gave me precious information concerning collecting grounds and local conditions.

HISTORICAL REVIEW

The scientific observation of Lepidoptera started in Portugal apparently around the middle of the 18th century. Linnaeus (1767, p. 773, no. 149) gave Portugal as habitat of *Satyrus hermione*. Fabricius (1781, vol. 2, p. 83, no. 366) described *Satyrus statilinus allionia* from Portuguese specimens and gave D. Gray as his source.

The earliest scientific publication dealing with Lepidoptera, and devoted exclusively to Portugal, is a list of the Portuguese fauna and flora by Dominicus Vandelli who dates his introduction April 1, 1787, but the paper was not published until 1797. In this list 32 species of Lepidoptera are mentioned from Portugal. Some of them are based on misidentifications and the names of others are not used by the generally known authors of the 18th century and can, consequently, hardly be recognized. There are no localities mentioned in this early publication, which has only historical interest.

Count Hoffmannsegg resided in Portugal from 1797 to 1800. He, himself, described new species, such as *Melanargia ines,* and also communicated much of his material to the famous authors of the end of the 18th century and the beginning of the 19th century. New species described at that time from Portuguese specimens include the following Rhopalocera: *Hesperia proto* Esp., *Thecla ilicis esculi* Hbn., *Zizera lysimon* Hbn. (Ochsenheimer, 1807–1816, vol. 1, chapter 2, p. 24, states that this species was discovered by Hoffmannsegg), *Cœnonympha pamphilus lyllus* Esp., *Euchloë belemia* Esp., and gen. æst. *glauce* Hbn. (Ochsenheimer, vol. 1, chapter 2, p. 160 confirms Portugal as habitat), and *Euchloë tagis* Hbn. Most of these species and subspecies were described from material collected by Hoffmannsegg. It is interesting to note that many widely distributed species were first found in Portugal and described from specimens captured there in these early times.

Illiger (1803, p. 184) described the difference between *Thais rumina* L. from Spain and those from Portugal, but did not name the Portuguese form, nor give the name of the collector.

Manoel Paulino d'Oliveira (born 1837, died 1899) was the leading Portuguese entomologist of his times. He devoted his life to the study of several orders of insects and generally sent the Lepidoptera which he collected to foreign specialists. *Symmoca nigromaculella* Rag., *Blastobasis fuscomaculella* Rag., and *Phalonia punctiferana* Rag., are among the species discovered by him. His collection was rather poor as far as Lepidoptera were concerned. It contained very few Microlepidoptera. This collection was acquired by the Museum of the University of Coimbra.

During the last two decades of the 19th century a relatively great number of lepidopterists studied the Portuguese fauna. Rev. A. E. Eaton visited Portugal in 1880 and captured 70 species of Macrolepidoptera, a list of which was published by Staudinger, while Ragonot and Stainton published a list of his 74 species of Microlepidoptera. The Eaton material is of particular interest in view of the fact that it originates in part from almost inaccessible areas of Alentejo and Algarve in southern Portugal. There has been practically no collecting done either before or after Eaton in these regions. *Tortrix œtoniana* Rag., was discovered by this successful collector.

Antonio Augusto de Carvalho Monteiro of Lisbon devoted himself mostly to the study of Rhopalocera and discovered and described *Satyrus actœa mattozi.* This form was named after F. Mattozo Santos, another lepidopterist active during the last two decades of the 19th century. Mattozo Santos made an attempt to publish a list of the Lepidoptera occurring in Portugal, but he reached only a total of 90 species (72 Macrolepidoptera and 18 Microlepidoptera).

The famous collector, Korb, spent some time around 1890 in Portugal and discovered in Algarve *Ptychopoda incisaria* Stgr. Emilio Biel of Pôrto was another collector who sent his material to Staudinger who described *Callimorpha dominula bieli.*

Th. Seebold published in 1898 a list of the Microlepidoptera from the Iberian Peninsula contained in his collection and numbering 683 species, of which only 64 are from Portugal. This

disproportion shows how little Portugal was known until the end of the 19th century. Unfortunately Seebold did not give the definite localities whence his Portuguese Microlepidoptera originated.

With the turning of the century, the interest in the exploration of the Portuguese fauna grew rapidly. Rev. Candido Mendes de Azevedo, professor at the famous College of S. Fiel, started in 1894 systematic collecting around his residence of all families of Lepidoptera during all seasons and for a period of eight years. He devoted much time also to the important breeding especially of Microlepidoptera. In 1902 when he left S. Fiel the number of species of Lepidoptera observed by him in this region amounted to 705 (407 Macrolepidoptera and 298 Microlepidoptera). For some species he failed to give the specific name; others are listed as doubtful. Nevertheless it can be said that S. Fiel is the best-explored region of Portugal and the papers published by Mendes are the most valuable contributions to the Portuguese fauna. The accuracy of his observations and the number of details given prove that Mendes was the greatest lepidopterist of all those who have studied the fauna of Portugal. Mendes did not limit his activity to the immediate vicinity of S. Fiel (altitude about 500 m.), but explored also the nearby Serra da Guardunha (1224 m.) and Serra da Estrêla (1991 m.), the latter only on occasional trips.

In 1907 Mendes returned to S. Fiel and found in this region a further 122 species (42 Macrolepidoptera and 80 Microlepidoptera). This brings to a total of 827 the number of species recorded from the region of S. Fiel. In this number are included those of which only the generic name is given and a limited number of doubtful records. The new species described by Mendes from the region of S. Fiel are: *Nepticula ilicis, Nepticula viridella, Coleophora pterosparti* and *Mendesia joannisiella.*

Mendes was in close contact with the leading lepidopterists of the early 20th century to whom he repeatedly sent material and whose comments and identifications are the best guaranty of the accuracy of Mendes' data. Rev. J. de Joannis of Paris was the closest friend of Mendes and certainly the greatest authority in the field of Palæarctic Microlepidoptera of those decades. Sev-

eral new descriptions were made by de Joannis from Mendes' material, among them the new genus *Mendesia* with its genotype *echiella*. New species described by de Joannis from S. Fiel are *Tortrix nervana* and *Rhyacia fidelis*.

Mendes did not limit his work to the interesting region of S. Fiel. His brother Manuel Mendes d'Azevedo explored in 1902 the region of Torres Vedras. Candido Mendes continued this work in 1906 and 1907 and Philippe Goularte de Souza concluded it in 1907 and 1908. From this region 185 species of Macrolepidoptera and 145 species of Microlepidoptera have been listed.

During a short trip, Mendes collected at Val de Rosal (Caparica do Monte), in the much neglected vicinity of Lisbon, 18 species of Macrolepidoptera and 23 species of Microlepidoptera.

Besides publishing the results of his own collecting, Mendes had also the great merit of studying and publishing the material of other lepidopterists, most of them his disciples. The earliest of these studies is based on the material collected by Rev. Luiz Maria Alves Correia in 1901 and 1902 around Campolide, consisting of 41 species of Macrolepidoptera and 24 species of Microlepidoptera.

In the extreme North of Portugal, near the Spanish border, in the mountains of Gerez (1536 m.), Rev. Joaquim da Silva Tavares (born 1866, died 1931), the great specialist of gall-forming insects, collected Lepidoptera during several seasons. The list published by Mendes enumerates 67 species of Macrolepidoptera and only 6 species of Microlepidoptera. Gerez seems to be the richest region in Portugal as far as the number of specimens of Rhopalocera is concerned. From 1926 to 1929 Maria Amélia de Silva Cruz and J. T. Wattison visited Gerez repeatedly and listed 241 species of Macrolepidoptera and no Microlepidoptera.

M. Rebimbas collected around Setúbal in 1901 and found around 150 species. He was followed by P. Vieilledent, a disciple of Mendes, who found during 1902–1904 a further 265 species in this same region. His list includes 271 species of Macrolepidoptera and 144 species of Microlepidoptera. Setúbal seems to be the second best known region of Portugal. Part of Vieilledent's material was identified by de Joannis of Paris.

Another disciple of Mendes was Julio de Moraes, who collected in the neighborhood of Felgueiras and Guimarães, in the northern district of Minho, 123 species of Macrolepidoptera and 50 species of Microlepidoptera according to the list published by Mendes.

During 1909 the Hon. N. Charles Rothschild paid a short visit to Portugal and found, around Sintra (207 m.), 50 species of Macrolepidoptera and 2 species of Microlepidoptera. H. Rebel described from his material the interesting *Melitæa dejone rosinæ*.

During the revolution of 1910, Mendes was expelled from Portugal and went to Salamanca, Spain, where he lived for a number of years in exile. He has been deprived of his library and collections, the latter having been deposited at the Museum of the University of Coimbra. Mendes continued, during his exile, the study of Portuguese Lepidoptera, but complained bitterly of the loss of his records and collections. His emigration was a great loss for our science.

It was many years after Mendes left Portugal before a new generation of lepidopterists appeared. This new generation was led by J. T. Wattison who not only collected himself, particularly in the northernmost district of Minho, but also published the records of Rothschild and the Rhopalocera to be found in the collections of the Museum of the University of Coimbra and Pôrto and the material of Timóteo Gonçalves. His work, published in 1928–1930, lists 108 species of Rhopalocera found in Portugal, of which he gives descriptions and figures. Besides the region of Gerez, already mentioned, he collected, together with Maria Amélia da Silva Cruz, in the vicinity of Vizela from 1928 to 1930, where they found 217 species of Macrolepidoptera. Unfortunately, no Microlepidoptera have been recorded by them.

The region of Caldelas was explored from 1926 to 1928 by Elisio Ferreira de Sousa, who found only 76 species. From 1930 to 1932 Maria Amélia da Silva Cruz continued the collecting in this region and listed a total of 220 species of Macrolepidoptera. No attention was paid to Microlepidoptera.

Orazio Querci resided in Portugal in 1927 and 1928 and collected Rhopalocera in the districts of Beira, Baixa, Extremadura and Algarve. Unfortunately the dates of capture are not men-

tioned in his paper. I had an opportunity to see some of his specimens in the Museum Bocage in Lisbon. This museum has been closed to the public for many years and the entomological collections are stored away in large tin containers.

In 1935 O. Lundblad collected in Portugal mainly Hemiptera and only a few Lepidoptera. His material originates from the Extremadura and Alentejo districts. Bryk (1940) has published a list of the 31 species of Macrolepidoptera collected during this trip, including *Cosymbia maderensis* Bethune Baker (1891, Trans. Ent. Soc. London, p. 216, pl. 12, fig. 5) with its ssp. *lundbladi* Bryk, forma *prouti* Bryk and forma *badiaria* Bryk. This interesting species was not found before in Portugal nor anywhere else on the European Continent. Due to wartime conditions I received Bryk's paper after my manuscript had been completed and could therefore not include in my systematic list the above new species, nor the numerous new descriptions of Bryk which refer to species already listed by me from Portugal and cover local races and individual aberrations.

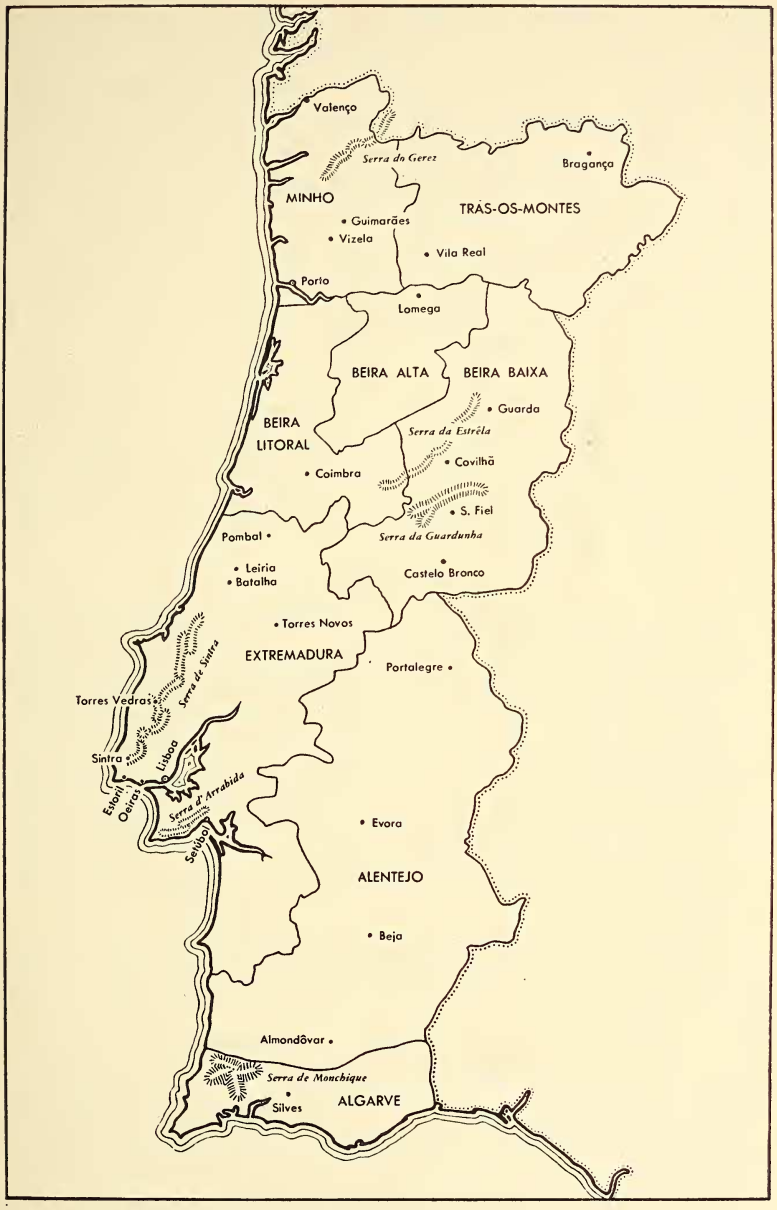
Finally the writer resided in Portugal from 1939 to 1941 and collected in different regions, but mainly in the western part of the Extremadura district, around Estoril, Oeiras, S. Amaro and Sintra. The reader may judge, from the following pages, if his attempt to explore, in such a short time, a good part of the Portuguese lepidopterous fauna, was a success or a failure.

GEOGRAPHY AND GEOLOGY

Portugal is situated at the southwesternmost tip of the Eurasiatic continent and stretches from 42° 9′ to 36° 58′ of northern latitude and from 9° 30′ to 7° of longitude east of Greenwich. It has an area of 89,106 sq. km.

Portugal is popularly divided into 8 districts, which are natural rather than political divisions; their names are used throughout this paper. The locations of these districts are shown on the outline map of Portugal which I am giving. The names of these 8 districts going from north to south are as follows: Minho, Trás-os-Montes, Beira Alta, Beira Litoral, Beira Baixa, Extremadura, Alentejo and Algarve.

The orogenic structure of Portugal is rather complex. Most geological ages are represented. The northern districts, namely



Outline Map of Portugal

Minho, Trás-os-Montes, as well as the districts of Beira Alta and Beira Baixa, are mostly of granite formation, except a large schist area in the southern and eastern part of Trás-os-Montes. The northern part of the Extremadura district is of Secundary origin with the exception of the region of Sintra which was formed by a later volcanic eruption and consists of granitic masses. The region immediately south of the Tagus River was formed in the Tertiary. Cambrian formations occur in the Alentejo district. The greater part of the southernmost Algarve district dates from the Carboniferous, with the exception of the granitoid Serra de Monchique which is due to a more recent volcanic eruption.

Portugal has no high mountains, nor glaciers. The highest elevation is 1991 m., in the Serra da Estrêla. According to Proença, only 0.57 per cent of the total area of Portugal has an elevation exceeding 1200 m.; that is, most of Portugal consists of hilly country and plains.

CLIMATE

The climate of Portugal shows the effects of the low altitude of most of the country and of its proximity to the Atlantic Ocean. The northern part constitutes an Atlantic climatic zone, exposed to the rainy winds coming from the Ocean, with high moisture and little variation in the temperature. The southern part of Portugal is much warmer and dry. From west to east the climate shows an evolution from the oceanic to the continental climate. Near to the Atlantic Coast the climate is under the influence of the Gulf Stream and the maximum daily oscillation does not exceed 20° C.

The yearly average temperature in Guarda, near the Serra da Estrêla is only 10.5° C. It rises to 17.9° C., at Lagos in the Algarve district.

To the south of the Tagus River the temperature rises considerably; in summer up to 50° C. In the same district, the minimum in January is as high as 11.7° C. In the Alentejo district with a more continental climate the daily oscillation is as high as 30° C.

As to the precipitation, which is equally important for the flora as directly for the Lepidoptera, the yearly average accord-

ing to Proença amounts for all Portugal to 965 mm. It is very unevenly distributed. The highest precipitation exists in the mountainous region. Serra da Estrêla has an annual average of 2464 mm. Going from the mountains to the plain and from the north to the south the precipitation decreases gradually. It amounts in Pôrto, to 1291 mm., Coimbra, 926 mm., Lisbon, 756 mm., and Faro 438 mm. annually. The rainy months are November and December, whereas the whole summer is extremely dry; almost no rain falls from early spring to late fall.

VEGETATION AND BIOTOPES

According to Proença, the number of species of plants known from Portugal exceeds 2700. Compared with the British Isles which have an area 3.5 times larger than that of Portugal and only 1848 species of plants, the Portuguese flora can be considered as rich. Spain is 5.5 times larger than Portugal and is known for its rich flora, which consists of 5089 species of plants.

Of Portuguese plants, 193 species are not known from Spain, but 34 of these occur elsewhere in Europe. There are 15 species occurring only in Portugal and North Africa. Ninety species of Portuguese plants are not known to have been found outside of Portugal and can therefore be considered as really endemic.

For further data concerning the Portuguese flora, I wish to refer to the very rich literature, the papers of Daveau, Pereira Coutinho, Telles Palinha and the serial Boletim da Sociedade Broteriana, Coimbra, which is devoted in great part to this subject.

The rich Portuguese flora is disproportionate if we compare it with the rather poor fauna of Lepidoptera. One of the reasons for this is that many species of Portuguese plants do not have a wide distribution, but are restricted to small areas, and even there some of them do not occur very frequently. Some of these plants are relicts; others are plants with wide distribution outside of Portugal, but rare in Portugal, which country is far removed from their centers of distribution. These plants continue to grow in such small colonies, but the Lepidoptera which once fed upon them may have disappeared, being not able to maintain themselves in such small populations.

Another peculiarity of the Portuguese flora which has a direct adverse effect on the Lepidoptera is the following. For many centuries exotic trees were planted in Portugal. This arborization was perpetuated on a large scale first by religious orders and later through government agencies. It was done in very large areas throughout Portugal. The result was that such exotic trees as *Eucalyptus globulus, Pinus halapensis* Mill., *Psudotsuga douglasi* and many others became acclimated and form at present great forests at many places, as around Bussaco and Sintra, where I observed repeatedly the poorness of the fauna. The aim of these human activities was to transform arid regions into dense forests. The local vegetation gave place to these imported trees, but not a single exotic Lepidopteran has been acclimated with these exotic trees in Portugal, and the species which occurred in Portugal previous to the arrival of these trees could not adapt themselves to the new foodplants. Generally speaking, these forests, particularly the *Eucalyptus* forests, have, besides this, a very poor undergrowth. I have never seen in Portugal areas which were as poor in Lepidoptera as the *Eucalyptus* forests of Sintra.

If we pass in review different parts of the western part of the Palæarctic region, we find that the optimal conditions for the greatest number of species of Lepidoptera exist in regions with a high amount of annual precipitation. The high amount of precipitation is a prerequisite for the existence of forests and the woodlands seem to offer the best biotopes for the greatest number of lepidopterous species. The greatest part of Portugal is rather arid and the woodland is restricted to the smaller part of Portugal. The low amount of precipitation does not permit the growth of large and rich forests composed of the most varied plants which are, in Central Europe, the habitats with the richest fauna of Lepidoptera.

The Portuguese vegetation does not include any of the extremes: there are no high mountains with glaciers and almost without any vegetation, nor do deserts with very little vegetation exist anywhere in Portugal. Swamplands covering large areas are also missing. Nevertheless the biotopes are rather varied. They range from mountain regions with only shrubs and few

small trees to dense forests at a few places, to heathery grounds covering large areas and to very dry plains.

We have noted the typical plants only for a very limited number of Portuguese biotopes, which we describe hereafter.

The slopes of the Serra do Gerez are a typical example of the rather rare Portuguese forests. Henriques (1885) wrote that the woodland in the Gerez goes up to a little over 1200 m. The most common trees are *Quercus toza* Bosc. and *Quercus pedunculata* Ehrh. With the oaks, can be found *Acer pseudoplatanus, Arbutus unedo* L., *Prunus lusitanicus, Betula pubescens* Ehrh., *Ilex aquifolium* and *Cratægus monogyna* Jacq. In the vicinity of these forests large areas covered by *Vaccinium myrtillus* can be found. This plant occurs in Portugal only in the Gerez region and in the Serra da Estrêla. A further characteristic plant of the Serra do Gerez is *Amelanchier vulgaris* which climbs to the highest points in this mountain. *Sphagnum* sp. also goes up to the highest elevations. Other typical plants of the Serra do Gerez are: *Vincetoxicum officinale, Eryngium duriacanum* and at higher altitudes, *Allium lusitanicum.* Among the rocks, *Sorbus aucuparia* grows.

The highest zone in the Gerez mountains is over 1200 m., and has no trees, but only a few scrubs. *Sphagnum acutifolium* is abundant. At moist places, *Erica tetralix, Merendera montana* and *Armeria willkommi* are found. Among the dry granitic rocks, *Raconitrium lanuginosum* is abundant and goes up to the summit (1536 m.).

Leaving the Minho district with its Gerez mountain, which is granitic, and with little Mediterranean influence in its floral character, as may be seen from the above, we find other granite formations in the Beira Baixa district. One of them is Serra da Guardunha with its peak of 1224 m. elevation. Here the vegetation is generally poor due to the aridity of the soil. The frequent woodcutting and the activity of the cattle are also unfavorable factors. Predominant plants of this region are *Cytisus albus* Lam., *Cistus ledon* Lam., *Cistus ladaniferus* L., *Lavandula pedunculata* Cav., many Graminaceæ, *Erica arborea* L., *Erica aragonensis* Wk., *Sarothamnus patens* Webb. and *Adenocarpus intermedius* DC. *Genista lusitanica* L. grows at higher altitudes. *Digitalis thapsi* L. is found everywhere on dry meadows.

Only the northern and western slopes of the Serra da Guardunha are of schist formation. Here are to be found *Cistus ladaniferus* L., *Pterospartum cantabricum* Spach., *Calluna vulgaris* Sal., *Erica umbellata* L., *Quercus toza* Bosc., *Arbutus unedo* L. and *Sarothamnus grandiflorus* Webb. The chestnut grows here and there and can be found up to 1070 m. altitude. There are vineyards at over 1000 m. altitude. The forests consist mainly of *Quercus pedunculata* Ehrh., pines and the imported *Eucalyptus globulus.*

Serra da Estrêla in the Beira Baixa district, which is in the vicinity of Serra da Guardunha, has an entirely granite formation and consequently a poor fauna of Lepidoptera.

Nearby Matta do Fundão, still in the Beira Baixa district, on Cambrian formation with large chestnut forests, is the richest spot in the region as far as Lepidoptera are concerned.

Around Torres Vedras, in the Extremadura district there is some woodland, consisting principally of *Quercus lusitanica* Lam. and *Quercus coccifera* L.

In the southernmost Algarve district the picture changes completely. The flora is entirely Mediterranean. *Ficus carica* L. covers large areas, the same as *Amygdalus communis* L., which is in flower in January–February. Other fruit trees, *Magnolia,* orange trees, *Olea europœa* L., *Ceratonia siliqua* L., *Quercus lusitanica* Lam., *Arbutus unedo* L., *Rhododendron* sp., *Platanus* sp. and cork oak are typical for this region.

CHARACTERISTICS OF THE LEPIDOPTEROUS FAUNA

Most families of Lepidoptera occurring in Europe are well represented in Portugal and there is not a single endemic family for this country. The following European families are not represented in Portugal: Phyllocnistidæ, Œnophilidæ, Heliodinidæ, Tinægeriidæ, Ochsenheimeriidæ, Heterogynidæ, Endromididæ, Bombycidæ (*Bombyx mori* L., the only European species of this family, is not cultivated in Portugal), Lemoniidæ.

I have here listed 1216 species of Lepidoptera which compare with the number of species known from other parts of the Western Mediterranean area as follows. According to Zerny (1935) there are 1300 species found in Albarracin, Aragon, Spain, which, however, is a much smaller area than Portugal. I did not find any

recent faunal lists from other parts of Spain. As to North Africa, in his excellent work Zerny (1935) lists 684 species from the Great Atlas, Morocco. This covers mostly a mountainous area with much less diversified biotopes than Portugal. Insular faunas are, the same as elsewhere, also in the Western Mediterranean the poorest. Bytinski-Salz (1934) gives a total of about 600 species of Lepidoptera for Sardinia and 875 species for Corsica. As to the Eastern Mediterranean, Ellison and Wiltshire (1939) list 757 species from the Lebanon. According to Amsel (1933), 1335 species occur in Palestine.

If we compare Portugal with the less dry areas in Central Europe, where large forests with rich undergrowth exist, the poorness of the Portuguese fauna becomes evident. Lower Austria has according to Zerny (1935), 3040 species of Lepidoptera, whereas in Hungary (Zerkowitz, 1927) there are 3250 species of Lepidoptera.

FAUNAL REGIONS

Our present knowledge of the distribution of the Lepidoptera over the globe shows that, instead of each species having its particular pattern of distribution, any species follows a pattern of distribution which is shared by a great many other species of diversified taxonomic groups. Each pattern of distribution corresponds to what we call a faunal region and the whole surface of the globe can be divided into a limited number of faunal regions. However, it must be observed that none of the faunal regions can be delineated by a definite straight line on the map because many species would cross such an imaginary line. Various elements penetrate more or less deeply into the main area occupied by the other type, as we will point out in detail on the following pages.

Whereas, all over the Western Hemisphere the principal mountain chains follow a more or less north–southern direction, in the Palæarctic, at least in its western part with which we are here particularly concerned, the higher mountains follow, almost without exception, a west–eastern direction. If we consider high mountains as boundaries of natural regions, this may explain the reason why in the Palæarctic region sharper subdivisions are possible according to the latitude than in America. In fact, it is generally accepted that the western part of the Palæarctic region

may be divided into the following subregions, each of which follows a certain degree of latitude and for which the longitudinal range of each is highly different:

Euro-Siberian Subregion
Mediterranean Subregion
Eremic or Desert Subregion

In the North, the Palæarctic region has common boundaries with the Circumpolar region, which has no representatives in Portugal, whereas in a southerly direction the Tropical regions, namely the Ethiopian region and the Indo-Australian region border the Palæarctic region. These two faunal regions have a few representatives occurring in Portugal.

Following the idea of faunal regions and subregions appeared to me as much more reflective of the facts of the actual distribution of any faunal unit than the system followed by a number of modern authors, such as Bates (1935) who, instead of attributing any unit to a particular fauna, examined merely the fact of its occurrence or absence in a number of neighboring areas.

Furthermore I have refrained from using as a unit for my observations the subspecies or race, as suggested by Bytinski-Salz (1934), knowing that the subspecific division of the specific nomenclatorial units is followed through very unevenly by modern taxonomists in the order Lepidoptera. There are many species in such specialized groups as the Rhopalocera which have been divided in a relatively great number of subspecific nomenclatorial units with only very small differences between one and the other, whereas in many families, particularly of the less studied Microlepidoptera, even important differences have not induced any taxonomist so far to describe and name any subspecies. Besides this practical consideration it seems to me that the geographical distribution of a species is a more stable fact than the geographical distribution of various subspecies, some of which may interbreed with others, whereas others cannot, and the genetic value of which is highly different. Furthermore most authors agree about a good species, whereas any given subspecies may be accepted by one author and rejected by another. For the same reasons I disagree with Bates (1935) concerning the term "choromorph," which, however, may have some justification if it is applied to insular faunas.

I have stated, therefore, in my systematic list the particular faunal subregion to which each species (and not subspecies) belongs and was, after careful study, obliged to use terms which in some instances are different from those generally found in the literature. The principal change which I made was subdividing the term "Euro-Siberian" which I have used in all instances. It seems to me that it is hardly possible to speak of a Euro-Siberian species, without using subdivisions. This would mean practically that a species known only from a limited part of Western and Central Europe has to come into the same zoogeographical group as a species distributed all over Europe and Asia, from the Atlantic to the Pacific coast, and known besides this, also from North America and the Tropics. I am surprised that such subdivisions, as I use for the first time here particularly for the Euro-Siberian species, have not been used before by any author.

For the purposes of this study, I was obliged to subdivide other regions also, principally the Western Mediterranean region, or Atlanto-Mediterranean region of Boursin (1943), which I replace by Endemic, Iberian, Atlantic and Western Mediterranean subregions in order to better show the type and extent of distribution of the species involved.

By attributing any given species to a zoogeographical category, I have not considered the hypothetical center of its distribution, but rather the whole area where the species can be regularly found. Areas where the species is found only exceptionally and as a straggler have not been considered.

The list of the terms used in this paper to designate faunal regions and subregions follows with the definition of each of them.

1) *Euro-Siberian.*—Distributed over part or most of temperate Europe and temperate Asia. Some species spread from Europe southward into North Africa, while others do not.

a) *Alpine.*—Restricted in its distribution to the Alps.

b) *Boreo-Alpine.*—Distributed over the Alps and occurring also in Northern Europe. Generally these species occur in Northern Europe at low altitudes or in the plain, whereas in the Alps most of them are found only at a certain altitude, often at considerable altitude.

c) *European.*—Occurring only in Europe, mainly in its temperate regions.

d) *Euroriental.*—Besides temperate Europe found also in Western Asia, some species even in Central Asia.

e) *Euro-Pacific.*—Spreading from Europe eastward as far as the Pacific coastal region of Asia.

f) *Holarctic.*—Widely distributed over the Palæarctic and Nearctic regions.

2) *Mediterranean.*—Distributed over part or most of the areas situated along the Mediterranean Sea. Most of them missing in the areas of desert character, such as Tripolitania, Cyrenaica, and Egypt.

a) *Endemic.*—Found only in Portugal.

b) *Iberian.*—Found only in Portugal and Spain.

c) *Atlantic.*—Spreading from the westernmost part of the Mediterranean area, particularly Portugal and Spain, northward along the Atlantic coast of Europe where the Gulf Stream is felt, the North Sea and sometimes even the Baltic Sea. The particular character of the species pertaining to this group is that they do not spread eastward into the European Continent.

d) *Western Mediterranean.*—Spreading along the European shores of the Mediterranean Sea as far as Southern France, Italy or eventually Dalmatia and along the African shores not beyond Tunisia.

e) *Circum-Mediterranean,* which I have abbreviated in the systematic list into *Mediterranean.*—Occurring in the western and eastern parts of the Mediterranean region.

f) *Ponto-Mediterranean.*—Found in the Mediterranean region and also along the shores of the Black Sea.

3) *Tropical.*—I have used this term irrespectively whether the particular species spreads into Europe from the Ethiopian region or from the Indo-Australian region or from both. The few Neotropical species occurring in Portugal have also been put into this category.—*Tropico-Holarctic* are species which spread from the Tropics not only into the Palæarctic but also into the Nearctic region.

I did not find any species pertaining to the interesting Canarian subregion occurring in Portugal, but found rather that such spe-

cies can be designated as Mediterranean. Furthermore I did not deem it necessary to attribute any species occurring in Portugal to the Eremic subregion. The influence on Portugal of the North African fauna in general is very light.

On the following pages I have counted the number of species pertaining to the various faunal regions and subregions and have figured the percentage of representation of each of them. I did this for particular reasons. Unfortunately I was not in a position to use geographical maps to illustrate continuous distribution of certain species, disrupted distribution of others and "insular" occurrence of still others. I mean the methods employed by Stegmann (1936) and other modern authors, which I highly appreciate. The limited number of single observations available from Portugal and the small size of the area involved do not justify the use of such maps as those used by Stegmann.

I give in Table I a general faunistic analysis of the Lepidoptera occurring in Portugal, stating for each family the number of species pertaining to each faunal region or subregion. The most characteristic fact that can be observed from this table is that families with numerous Mediterranean representatives are generally well represented in Portugal, whereas families consisting mostly of Euro-Siberian species are generally poorly represented in Portugal.

The Tortricidæ, greatly depending on deciduous trees and consequently with more northern distribution, are poorly represented in Portugal, whereas the Pyralidæ, which are characteristic for the Mediterranean fauna and even for the tropics, are among the well-represented families. Zygænidæ, a family generally well represented in the Euro-Siberian region, in number of species as well as specimens, is particularly poorly represented in Portugal, but the same thing can be said for a great part of the Mediterranean region as far as this particular family is concerned. Geometridæ and Noctuidæ are both well represented with numerous Mediterranean species.

Among the Rhopalocera there are more species of Nymphalidæ listed than Satyridæ, but most Nymphalidæ are only locally distributed or rare, whereas the Satyridæ have a wide distribution in Portugal and many species are very common. One of the most

TABLE I

FAUNISTIC ANALYSIS OF THE LEPIDOPTERA OCCURRING IN PORTUGAL

Families	Euro-Siberian						Mediterranean						Tropical		Total
	Alpine	Boreo-Alpine	European	Eurorientalt	Euro-Pacific	Holarctic	Endemic	Iberian	Atlantic	Western Mediterranean	Circum-Mediterranean	Ponto-Mediterranean	Tropical	Tropico-Holarctic	Number of species
Hepialidæ	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Micropterygidæ	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Eriocraniidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Incurvariidæ	.....	.....	2	1	.....	.....	.....	1	.....	1	1	.....	.....	.....	6
Nepticulidæ	.....	.....	10	2	.....	.....	3	.....	6	5	.....	.....	.....	.....	26
Tineidæ	.....	.....	2	3	.....	6	.....	1	.....	1	2	.....	.....	.....	15
Monopidæ	.....	.....	.....	2	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	3
Talaeporiidæ	.....	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	2
Psychidæ	.....	.....	.....	2	1	.....	.....	1	.....	2	3	.....	.....	.....	9
Tischeriidæ	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Cemiostomidæ	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Lyonetiidæ	.....	.....	2	.....	.....	1	.....	.....	.....	3	.....	.....	.....	.....	6
Graciliariidæ	.....	.....	17	12	1	.....	2	1	1	5	3	.....	.....	.....	42
Coleophoridæ	.....	.....	11	3	.....	.....	1	1	1	.....	1	1	.....	.....	19
Elachistidæ	.....	.....	1	3	.....	.....	2	.....	.....	1	1	.....	.....	.....	8
Heliozelidæ	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Scythrididæ	.....	.....	1	1	.....	.....	.....	2	1	2	2	.....	.....	.....	9
Hyponomeutidæ	.....	.....	7	.....	.....	.....	.....	.....	.....	1	4	.....	.....	1	13
Acrolepiidæ	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
Aegeriidæ	.....	.....	1	4	1	.....	.....	.....	.....	1	1	.....	.....	.....	8
Glyphipterygidæ	.....	.....	8	.....	.....	.....	.....	.....	.....	1	2	.....	.....	.....	11
Gelechiidæ	.....	.....	26	29	.....	2	2	9	3	11	15	3	.....	1	101
Momphidæ	.....	.....	1	3	.....	.....	.....	.....	1	.....	2	.....	.....	.....	7
Atychiidæ	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	2
Cossidæ	.....	.....	.....	3	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	4
Tortricidæ	.....	.....	20	29	5	13	1	4	6	5	7	1	.....	2	93
Orneodidæ	.....	.....	.....	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	2

Families	Euro-Siberian						Mediterranean						Tropical		Total
	Alpine	Boreo-Alpine	European	Eurorientalal	Euro-Pacific	Holarctic	Endemic	Iberian	Atlantic	Western Mediterranean	Circum-Mediterranean	Ponto-Mediterranean	Tropical	Tropico-Holarctic	Number of species
Pterophoridæ	×	.....	2	6	.....	1	.....	.....	.....	2	3	.....	.....	.....	14
Pyralidæ	.....	1	47	12	1	9	1	2	3	17	45	2	2	7	149
Thyrididæ	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Zygaenidæ	.....	.....	1	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
Limacodidæ	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Geometridæ	.....	1	16	73	18	4	.....	5	2	45	31	1	1	1	198
Drepanidæ	.....	.....	.....	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
Cymatophoridæ	.....	.....	.....	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
Lasiocampidæ	.....	.....	.....	5	2	.....	.....	2	.....	2	.....	.....	.....	.....	11
Thaumetopœidæ	.....	.....	1	.....	.....	.....	.....	1	.....	.....	1	.....	.....	.....	3
Lymantriidæ	.....	.....	.....	.....	4	3	.....	.....	.....	1	1	.....	.....	.....	9
Notodontidæ	.....	.....	.....	.....	10	.....	.....	.....	.....	1	1	.....	.....	.....	12
Noctuidæ	.....	.....	17	101	44	8	1	9	2	19	25	13	3	2	244
Arctiidæ	.....	.....	3	11	8	1	.....	1	.....	2	5	.....	1	.....	32
Syntomidæ	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Saturniidæ	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Sphingidæ	.....	.....	.....	7	3	.....	.....	.....	.....	.....	1	1	2	1	15
Hesperiidæ	.....	.....	1	4	4	.....	.....	1	.....	3	1	.....	.....	.....	14
Lycænidæ	.....	.....	1	8	9	.....	.....	.....	.....	5	3	.....	2	.....	28
Erycinidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	2
Nymphalidæ	.....	.....	3	5	13	3	.....	.....	.....	2	2	1	.....	1	30
Satyridæ	××	.....	2	12	1	.....	.....	.....	.....	6	2	1	.....	.....	24
Danaidæ	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Pieridæ	.....	.....	.....	4	4	2	.....	.....	.....	2	2	.....	.....	.....	14
Papilionidæ	.....	.....	.....	1	.....	1	.....	.....	.....	1	.....	.....	.....	.....	3
Total number of species	.....	2	211	359	135	56	13	42	27	148	171	24	11	17	1216

× = *Stenoptilia graphodactyla* Tr. Doubtful.

×× = *Erebia evias* God. Doubtful.

conspicuous facts concerning the composition of the fauna at any given locality in Portugal is the abundance of Satyridæ and the absence or rarity of Nymphalidæ. This fact may be easily explained, the Nymphalidæ being in many instances inhabitants of woodlands or meadows with rich vegetation, whereas Satyridæ occur among rocks and on dry meadows with poor vegetation.

The number of families with only Euro-Siberian species and not a single Mediterranean species is rather large, amounting to 15. The number of families which do not have any Euro-Siberian representative in Portugal, but only Mediterranean or Tropical species is more reduced, being only 4: Talæporiidæ, Acrolepiidæ, Atychiidæ and Danaidæ. These families are rather characteristic for Portugal.

As to the percentage of representation for the various faunal regions and subregions, the following enumeration gives the answer.

Alpine elements	doubtful	
Boreo-Alpine elements	0.2	
European elements	17.4	
Euroriental elements	29.6	
Euro-Pacific elements	11.1	
Holarctic elements	4.6	
Total of Euro-Siberian elements		62.9
Endemic elements	1.1	
Iberian elements	3.4	
Atlantic elements	2.2	
Western Mediterranean elements	12.1	
Circum-Mediterranean elements	14.1	
Ponto-Mediterranean elements	1.9	
Total of Mediterranean elements		34.8
Tropical elements	0.9	
Tropico-Holarctic elements	1.4	
Total of Tropical elements		2.3
Grand total		100.0

ORIGIN AND EVOLUTION OF THE FAUNA

The absence of any substantial number of fossil Lepidoptera makes it very hazardous to risk a positive statement as to the past of any lepidopterous fauna, the known facts about palæobotany, palæoclimatology and geology being definitely insufficient to permit more than speculation in this respect. Therefore I do not

expect to prove the veracity of the statements which will follow, nor do I expect that their falseness can be proved.

Portugal being located within an area which is generally considered as forming part of the Mediterranean region, it can be said that its original fauna is represented by Mediterranean elements. As to its age, little can be said. It is, however, generally accepted as a fact by geologists and palæoclimatists that Portugal was not covered during any of the glacial ages by the icecap which protruded from the North. To the contrary, it can be assumed that at a time when a great part of the European continent was covered by ice and the insect populations died or emigrated, the Iberian Peninsula did not suffer from such drastic climatic changes and a great part of the insect fauna continued its existence. It can therefore be assumed that the Mediterranean elements of our fauna are generally of pre-glacial age. However, we do not know if these elements underwent, since the pre-glacial times, changes leading to the formation of new species or subspecies.

It has to be observed here that the Mediterranean area is far from being homogenous. It can be very easily divided into Western and Eastern Mediterranean regions. Not only does the eastern part of the Mediterranean region have a very special fauna (Anatolian-Iranian region) but we find that the Western Mediterranean elements are even more numerous in Portugal than the elements with Circum-Mediterranean distribution. I come to this conclusion if I compare the number of elements in all those faunistic groups which occur only in the western part of the Mediterranean with the number of elements in those faunistic groups occurring equally in the Eastern Mediterranean. This comparison gives the following result in percentages.

	Western Mediterranean	Eastern Mediterranean
Endemic elements	1.1	
Iberian elements	3.4	
Atlantic elements	2.2	
Western Mediterranean elements	12.1	
Circum-Mediterranean elements		14.1
Ponto-Mediterranean elements		1.9
Total	18.8	16.0

The vegetation and climatic conditions in the western and eastern part of the Mediterranean being very similar, this split in the fauna and the predominance of the Western Mediterranean elements can certainly not be explained by present but only by past conditions.

It is interesting to note how few endemic species are known from Portugal. There are more than three times more Iberian species, that is, species found only in Portugal and Spain, than species found in Portugal only. If we consider that Portugal is separated from Spain by political rather than natural frontiers, this fact is not surprising at all. There is no high mountain, ocean, desert or other impenetrable barrier between Portugal and Spain.

Another interesting fact is the very limited number of both Endemic and Iberian species in comparison with Western Mediterranean species. There are over three times more Western Mediterranean species recorded than Iberian species. This means practically that the Pyrenees with their impenetrable altitudes and the Strait of Gibraltar do not form a barrier to the distribution of a number of species. Over three times more species cross one or both of these barriers than species which do not cross them. This is certainly an interesting fact and any explanation is rather speculative.

If we consider that the most primitive part of the Portuguese fauna is that of Mediterranean origin, we can assume that the additional elements which at present form part of the Portuguese fauna have originated either in the North or in the South. The Euro-Siberian elements have spread from the north whereas the tropical elements have come to Portugal more or less from the south.

It is interesting to note that the Alpine and Boreo-Alpine faunal groups are represented in the Portuguese fauna only by a remarkably low number of elements. This can hardly be attributed to the great distance separating Portugal from the Alps, if we consider the fact that Zerny (1935) found an Alpine species (*Rhyacia helvetina* B.) as far from the Alps as the Great Atlas mountain in Morocco. The scarcity of Alpine and Boreo-Alpine elements in Portugal may be rather due to the low elevation of the Portuguese mountains.

The number of elements pertaining to the other subdivisions of the Euro-Siberian region is relatively high. It can hardly be expected that Portugal, being located within an area that is generally considered as forming part of the Mediterranean region, would have a fauna consiting of only about one-third (34.8 per cent) of Mediterranean elements and almost two-thirds (62.9 per cent) of Euro-Siberian elements. These figures include also Euro-Siberian species which have in Portugal no continuous distribution, being far apart from their center of distribution, but have only an "insular" distribution in Portugal. This means that they are found in Portugal only occasionally and in a limited number of localities. The best example which I can offer to illustrate this "insular" distribution is *Abraxas grossulariata* L., which is certainly one of the commonest and most widely distributed species of the Euro-Siberian region, whereas in Portugal it was found only in one single locality and even there only on one occasion. Such species are hardly an equivalent of certain extremely common Mediterranean species with wide distribution all over Portugal.

We must not overlook, in an endeavor to find an explanation of the above paradoxical ratio between Euro-Siberian and Mediterranean species occurring in Portugal, that the above figures are based on the fauna of Portugal as a whole. Portugal is far from being a homogeneous faunal region. It could rather be divided into small areas, some of them with strong Euro-Siberian characters, whereas others are mostly Mediterranean. Generally speaking, the Euro-Siberian character decreases in north-southern direction while the Mediterranean character increases. We illustrate these facts in Tables II, III and IV.

The percentages of representation of the faunal elements in the districts shown in Tables II, III, and IV are as follows:

	Minho	Alentejo	Algarve
Alpine elements	doubtful	.....	.....
Boreo-Alpine elements	.....	.....	doubtful
European elements	10.5	8	13.6
Euroriental elements	37.9	24	25.4
Euro-Pacific elements	21.7	8	3.4
Holarctic elements	6.3	4	3.4
Total of Euro-Siberian elements	76.4	44	45.8

Endemic elements	.....	.....	1.7
Iberian elements	1.1	.....	6.8
Atlantic elements	0.4	.....	1.7
Western Mediterranean elements	6.4	28	18.6
Circum-Mediterranean elements	9.7	28	22.0
Ponto-Mediterranean elements	2.2	.....	.....
Total of Mediterranean elements	19.8	56	50.8
Tropical elements	2.0	.....	1.7
Tropico-Holarctic elements	1.8	.....	1.7
Total of Tropical elements	3.8	.....	3.4
Grand total	100.0	100	100.0

The above figures show clearly that the northernmost Minho district has the most developed Euro-Siberian character with over three-quarters of its species (76.4 per cent) being Euro-Siberian. Less than one-fifth (19.8 per cent) is Mediterranean. In this respect the Minho district is hardly more Mediterranean in its character than many regions in the southern part of Central Europe which are not within the limits of what is generally considered as forming part of the Mediterranean area. The data which I gave in previous chapters, namely, concerning the high precipitation and the dense forests quite unusual in the Mediterranean region, may account for the particular character of Northern Portugal in general and the Minho district in particular.

As to the southernmost Alentejo and Algarve districts, the figures which I gave, show exactly the opposite picture: the percentage of the Euro-Siberian elements (44 per cent and 45.8 per cent) is somewhat less than half of the total, whereas the percentage of Mediterranean elements (56 per cent and 50.8 per cent) is higher than half of the total number of species occurring in these two districts. I have pointed out in the respective chapters the dry climate of these regions and their Mediterranean flora, which may be the explanation of these facts.

NORTH AMERICAN SPECIES OCCURRING IN PORTUGAL

The number of species found in Portugal which also occur in the Western Hemisphere is relatively high. We have mentioned

TABLE II

Faunistic Analysis of the Lepidoptera Occurring in the Minho District

Families	Euro-Siberian					Mediterranean					Tropical		Total
	Alpine	European	Eurorientalal	Euro-Pacific	Holarctic	Iberian	Atlantic	Western Mediterranean	Circum-Mediterranean	Ponto-Mediterranean	Tropical	Tropico-Holarctic	Number of species
Hepialidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Incurvariidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Psychidæ	.....	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	2
Gracilariidæ	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Scythrididæ	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
Hyponomeutidæ	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Ægeriidæ	.....	.....	2	1	.....	.....	.....	.....	.....	.....	.....	.....	3
Glyphipterygidæ	.....	2	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	3
Gelechiidæ	.....	3	4	.....	.....	.....	.....	.....	1	1	.....	.....	9
Momphidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Cossidæ	.....	.....	1	.....	1	.....	.....	.....	.....	.....	.....	.....	2
Tortricidæ	.....	1	2	2	2	.....	.....	.....	.....	.....	.....	.....	7
Pterophoridæ	.....	.....	2	.....	1	.....	.....	.....	.....	.....	.....	.....	3
Pyralidæ	.....	13	5	1	5	.....	.....	.....	2	.....	2	1	29
Thyrididæ	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1
Zygænidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Limacodidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Geometridæ	.....	9	49	11	3	1	1	10	16	1	1	1	103
Drepanidæ	.....	.....	1	2	.....	.....	.....	.....	.....	.....	.....	.....	3

TABLE II—(*Continued*)

Families	Euro-Siberian					Mediterranean					Tropical		Total
	Alpine	European	Euroriental	Euro-Pacific	Holarctic	Iberian	Atlantic	Western Mediterranean	Circum-Mediterranean	Ponto-Mediterranean	Tropical	Tropico-Holarctic	Number of species
Cymatophoridæ	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	2
Lasiocampidæ	.....	.....	5	2	.....	.....	.....	2	.....	.....	.....	.....	9
Thaumetopœidæ	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
Lymantriidæ	.....	.....	.....	4	3	.....	.....	.....	1	.....	.....	.....	8
Notodontidæ	.....	.....	.....	10	.....	.....	.....	.....	1	.....	.....	.....	11
Noctuidæ	.....	11	58	30	8	2	1	5	10	7	2	2	136
Arctiidæ	.....	1	8	7	.....	1	.....	1	2	.....	.....	.....	20
Saturniidæ	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	2
Sphingidæ	.....	.....	4	2	.....	.....	.....	.....	1	.....	2	1	10
Hesperiidæ	.....	1	2	4	.....	1	.....	1	.....	.....	.....	.....	9
Lycænidæ	.....	1	5	6	.....	.....	.....	2	2	.....	2	.....	18
Erycinidæ	.....	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	2
Nymphalidæ	.....	3	4	9	3	.....	.....	1	2	.....	.....	1	23
Satyridæ	x	1	10	.....	.....	.....	.....	5	1	1	.....	.....	18
Danaidæ	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Pieridæ	.....	.....	4	4	2	.....	.....	.....	.....	.....	.....	.....	10
Papilionidæ	.....	.....	1	.....	1	.....	.....	1	.....	.....	.....	.....	3
Total number of species	x	48	173	99	29	5	2	29	44	10	9	8	456

x = *Erebia evias* God. Doubtful.

on Table I a total of 56 Holarctic species, *i.e.*, species occurring in the Palæarctic and Nearctic regions, and 17 Tropico-Holarctic species, *i.e.*, species occurring in the Palæarctic and Nearctic regions and also in one or several tropical regions. This represents about 6 per cent of the total number of species occurring in Portugal, which is certainly an unusually high percentage.

TABLE III

Faunistic Analysis of the Lepidoptera Occurring in the Alentejo District

Families	Euro-Siberian				Mediterranean		Total
	European	Eurorientalal	Euro-Pacific	Holarctic	Western Mediterranean	Circum-Mediterranean	Number of species
Nepticulidæ	.....	.....	.....	.....	1	.....	1
Tineidæ	.....	.....	.....	1	.....	.....	1
Gracilariidæ	.....	.....	.....	.....	1	.....	1
Scythrididæ	.....	.....	.....	.....	.....	1	1
Hyponomeutidæ	.....	.....	.....	.....	.....	1	1
Glyphipterygidæ	.....	.....	.....	.....	1	.....	1
Gelechiidæ	.....	1	.....	.....	1	1	3
Tortricidæ	1	2	1	.....	.....	.....	4
Pterophoridæ	.....	1	.....	.....	.....	.....	1
Pyralidæ	1	.....	.....	.....	.....	2	3
Geometridæ	.....	1	.....	.....	2	.....	3
Hesperiidae	.....	.....	1	.....	.....	1	2
Satyridæ	.....	1	.....	.....	1	.....	2
Pieridæ	.....	.....	.....	.....	.....	1	1
Total number of species	2	6	2	1	7	7	25

It may be of interest particularly for the American readers if we examine the zoogeographical significance of these species. Portugal being situated at the westernmost tip of the European continent, we can assume that the relatively high number of species common to Portugal and North America may be explained by the geographical situation of Portugal. This theory may be defended only if we take it for granted that the majority of spe-

TABLE IV

FAUNISTIC ANALYSIS OF THE LEPIDOPTERA OCCURRING IN THE ALGARVE DISTRICT

Families	Euro-Siberian					Mediterranean					Tropical		Total
	Boreo-Alpine	European	Euroriental	Euro-Pacific	Holarctic	Endemic	Iberian	Atlantic	Western Mediterranean	Circum-Mediterranean	Tropical	Tropico-Holarctic	Number of species
Incurvariidæ	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1
Nepticulidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Tineidæ	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	2
Gracilariidæ	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1
Coleophoridæ	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Glyphipterygidæ	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Gelechiidæ	x	2	1	.....	.....	.....	2	1	.....	3	.....	.....	9
Tortricidæ	.....	.....	.....	.....	2	.....	.....	.....	.....	1	.....	.....	3
Pterophoridæ	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Pyralidæ	.....	3	1	.....	.....	1	.....	.....	1	1	.....	.....	7
Geometridæ	.....	.....	2	.....	.....	.....	.....	.....	4	1	.....	.....	7
Noctuidæ	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	2
Arctiidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Saturniidæ	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Hesperiidæ	.....	.....	.....	.....	.....	.....	.....	.....	2	1	.....	.....	3
Lycænidæ	.....	.....	4	1	.....	.....	.....	.....	2	2	1	.....	10
Nymphalidæ	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1
Satyridæ	.....	.....	2	.....	.....	.....	.....	.....	2	.....	.....	.....	4
Pieridæ	.....	2	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	3
Total number of species	x	8	15	2	2	1	4	1	11	13	1	1	59

x = *Gelechia viduella* F. Doubtful.

cies spread from the Old World into the New World over the Atlantic route instead of spreading over the Pacific route.

The spreading of most species took place during past geological ages when the geographical situation of the continents was different from their present situation and even the climates were different from present climates. Without any positive knowledge during which particular age the spreading took place we cannot study the routes over which our species spread in the light of past geological and palæoclimatic facts and have to base our observations on the probable stepping stones where the species involved occur at present.

In the following tabulations I have excluded those species which apparently did not spread due to natural factors, but the spreading of which was directly caused or favored by human interference. We may call the spreading due to natural causes, primary distribution and the spreading caused or favored by human interference, secondary distribution. I give below the names of 18 species which seem to pertain to the latter category with indications concerning the types of human activity that was apparently the cause of their distribution: *Trichophaga tapetiella* L. (human clothing); *Tinea granella* L. (culture of grains); *Tinea cloacella* Hw. (dried fruits); *Tinea fuscipunctella* Hw. (human habitations); *Tinea pellionella* L. (human clothing); *Tineola biseliella* Hummel (human clothing); *Lita solanella* B. (cultivation of potatoes); *Zeuzera pyrina* L. (cultivation of fruit trees); *Sparganothis pilleriana* Schiff. (cultivation of vine); *Carpocapsa pomonella* L. (cultivation of fruit trees); *Achroia grisella* F. (apiculture); *Galleria mellonella* L. (apiculture); *Plodia interpunctella* Hbn. (dried fruits); *Ephestia kuehniella* Z. (stored products); *Ephestia figulilella* Gregson (dried fruits); *Ephestia elutella* Hbn. (stored products); *Pyralis farinalis* L. (stored products); and *Pieris rapæ* L. (cultivation of cabbage).

The above species of secondary distribution are all widely distributed in the Old World as well as in the New World; there is only one of them which is limited in its distribution to the western part of North America, 4 are limited to the eastern part and the great majority of 13 species can be found from the Atlantic to the Pacific coast of North America. These species do not follow

natural causes in their distribution, but may occur wherever the human activity which provides them with the food they eat exists. Those living inside of human habitations do even not depend on the natural climate of their area of distribution. For these reasons I exclude them from the following tabulations, because they would certainly distort the picture. The only observations which I want to make in their regard is, that there is only one among these species the spreading of which took place in recent years and where we have the certainty that it spread over the Atlantic route. I mean *Pieris rapæ* L. But even the spreading of this species was rather accidental. As far as the original center of distribution of these 18 species is concerned, we can assume that most of them have spread from the Old World into the New World. They are generally more frequent and have a wider area of distribution in the Palæarctic than in the Nearctic and the human activity which provides their food is older in the Old World than in the New World. There is one exception to this: *Lita solanella* B., the foodplant of which, the potato, originates from the Nearctic region and which may therefore have spread from the Nearctic into the Palæarctic. Nevertheless even in this case we cannot have an absolute certainty because it is quite possible that the foodplant of this species was originally any wild species of the family Solanaceæ growing in the Palæarctic from which the larva may have gone over to the potato after the introduction of that plant in the Palæarctic.

After putting aside the 18 species of secondary distribution which we have discussed above, we have 55 species of primary distribution left. The first question which we have to examine in respect to their zoogeographical status is whether it can be assumed that these species have spread from the Palæarctic into the Nearctic or in the opposite direction.

There is only one species: *Danais plexippus* L., for which we can state with certainty that it has spread from the Nearctic into the Palæarctic. This species is not a regular element of the Palæarctic fauna and in particular of the European continent. It has been found only on very exceptional occasions and mostly only single specimens have been observed. The center of distribution of this species is certainly within the Nearctic and Neotropical

regions from which this highly migratory species spreads in western and eastern directions.

There are a few other species which are widely distributed to such an extent that it is hard to say whether the center of their distribution can be found in the Palæarctic or rather in the Nearctic or even in one of the tropical regions where these species of universal distribution occur. The most typical examples of these geopolitan species are *Plutella maculipennis* Curt, which occurs almost everywhere going northward up to Spitzbergen and southward deep into the tropics and *Nomophila noctuella* Schiff., which is also as widely distributed in the temperate and tropical regions of the Old World as it is in both regions of the New World.

It can be said about most or all of the remaining 52 species that they have spread from the Palæarctic into the Nearctic and not in the opposite direction. As to the routes which these species may have followed the following figures of the number of species occurring in various regions may enlighten us:

Species occurring in Northwestern Europe (Scandinavia, Finland, Lapland, etc.)	23
Species occurring on the Southern Atlantic Islands (Maderia, Canaries, etc.)	7
Species occurring in Portugal	52
Species occurring in East Asia (Amurland, Japan, Korea, etc.)	21
Species occurring in Australia and on Pacific Islands, Hawaii, etc.	6

The above figures show that in spite of Portugal being a southern area, the number of the species spreading northward (first and fourth group) is far higher than the number of those spreading southward (second and fifth group). This may be due to the fact that at present, (and probably even more so during the age or ages when these species spread from the Old World into the New World) in the northern regions there are less important barriers between the Palæarctic and the Neartic, than in the south where extensive oceans separate the continents.

If we examine the east-western distribution of our above 52 species, we find that the number of those spreading over the Atlantic route (first and second group) is only slightly higher than the number of those which follow the Pacific route (fourth

and fifth group). This seems to be only a coincidence due to the fact that most of the Holarctic species have a very wide distribution over the Palæarctic and occur in its Atlantic as well as Pacific areas and some go even into the tropics. The best proof of our statement that the ratio of the east-western distribution of these species in the Palæarctic region does not have much significance may be found in the distribution in east-western direction of the same 52 species in the Nearctic region, which gives us the following figures:

Species occurring only in the western part of North America	3
Species occurring in the western as well as eastern part of North America	30
Species occurring only in the eastern part of North America	19

These figures certainly show an overwhelming majority of the species occurring in Portugal which are found in North America only in its eastern part, in the Atlantic States. This ratio seems to indicate that the spreading of Portuguese Lepidoptera into North America took place in more numerous instances over the Atlantic route than over the Pacific route. At the same time this may be the explanation of the fact why Portugal, located at the westernmost tip of Europe, has a relatively great number of species occurring in the New World.

If we study the whole area of distribution of the Holarctic and Tropico-Holarctic species occurring in Portugal, we come to the conclusion that they may have followed four routes in their spreading into North America. For several species it is rather easy to follow their route, whereas in a few border cases there may be some doubt as to which route they have followed. Hereafter I give for each of the four routes the most typical species and state the approximate total number of species which may have followed that route. These figures concern the 52 species studied.

1) Northern Atlantic route. Total number of species, 27. Example: *Acalla logiana* Schiff., which occurs in the Palæarctic only in Europe and goes as far north as Lapland. In the Nearctic it occurs only in the Atlantic region. The genus *Acalla* could also serve as an example, all Holarctic species being absent in East Asia, going far into Northern Europe and most of them

restricted in their distribution in the New World to the northeastern part of that hemisphere.

2) Southern Atlantic route. Total number of species, 13. Example: *Bedellia somnulentella* Z., which does not occur in Asia, but is widely distributed in Southern Europe, on Maderia, the Canary Islands, etc., and known from North America only from the Atlantic states.

3) Northern Pacific route. Total number of species, 8. Example: *Papilio machaon* L., which occurs in Alaska and in subarctic America in general, in the form *aliaska* Scudder of which the northeastern Siberian form *orientis* Verity is a synonym, whereas specimens from northern Europe are very different.

4) Southern Pacific route. Total number of species, 4. Example: *Laphygma exigua* Hbn., which has an extremely wide distribution in the Orient, in India, Australia, and has been found even on Hawaii. On the American continent its distribution is rather western: California, Colorado, etc.

SYSTEMATIC LIST

In the following systematic list I have followed the nomenclature of Seitz (1907–1921) for all families contained in that work, whereas for all other families I adhered to the nomenclature of Spuler (1908–1910). Only in the sequence of families have I deviated from these works following a system which corresponds to our present knowledge of the true relationship between families of Lepidoptera according to their evolution. I have started with the most primitive groups and have ended the list with the most specialized families.

The items covered after the designation of the family are ordered as follows: number—genus—species—important synonyms—zoogeographical category—abbreviation of the name of district followed by the name of locality or localities in alphabetical order within such district—month or months in which imago was captured at the respective locality. If several annual broods can be clearly distinguished each brood is separated from the others by semicolon—characteristic environment or peculiarities of habit and remarks—month or months when egg, larva and pupa were observed—food plants—name of collector or identifier

whenever of particular interest or bibliographic references—subspecifically named forms.

It was not always possible or necessary to give information on each item as outlined above, but each listing of species follows this general form.

The names of districts have been arranged in geographical succession in north–southern direction and the following abbreviations have been used:

Ale = Alentejo	BL = Beira Litoral
Alg = Algarve	E = Extremadura
BA = Beira Alta	M = Minho
BB = Beira Baixa	T = Trás-os-Montes

It may be seen that whereas some regions of Portugal are relatively well explored, others such as the southern districts Alentejo and Algarve are almost unknown. To my knowledge there was never a resident collector in these districts and all the material was collected on short trips. The time I have spent myself in Portugal was definitely too short to explore under prevailing wartime conditions all 8 districts. I wish to draw particularly to the attention of lepidopterists, who may have the opportunity to explore the Portuguese fauna in the future, these two districts which have a very strong Mediterranean character and where many discoveries can certainly still be made.

As to the phenology, I have stated the months of capture for all specimens collected by myself. As to the records of other collectors, I have given the months wherever available. The dates of capture are given separately for each locality. They are certainly not complete. At some localities only the first annual brood was observed; at others only the second, or the species, has been observed only during part of its period of flight, or only the full-grown larva was collected. Nevertheless the separate listing of the phenology at each locality gives a fair idea of the variations existing within Portugal. Generally in northern Portugal the imago emerges later than in the south. The same thing holds true also for the mountainous areas. Furthermore in the south, some species are on the wing much later during the fall and even in winter. In some instances the number of annual broods is higher in the southern districts than in northern Portugal or in the

mountains. A few species are observed, as a consequence of the mild winter, in the imaginal stage practically during the whole year. If we compare the phenology given in the following systematic list with the indications to be found in such handbooks as Seitz and Spuler, we can observe that my data differ considerably from theirs. Most handbooks give the phenology as it can be observed in Central Europe, where many species are found in the imaginal stage later in the spring and summer or earlier in the fall than in Portugal.

The indication of foodplants refers always to Portuguese records, that is plants on which the respective species has actually been observed in Portugal, and not to foodplants on which species are quoted to be found in other regions. The foodplants are therefore not stated for many species, but even with the incomplete data given it can be seen that several species feed in Portugal on a different plant than the one mentioned in the literature from other countries.

(*To be continued*)